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Optimizing Greenhouse Corn Production: What Is the Best Fertilizer Formulation and Strength?

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Purdue Methods:
Optimizing Greenhouse Corn Production

What is best fertilizer formulation and strength?

Our goal was to design a growing system for corn using automated drip irrigation to apply a general purpose fertilizer solution several times daily. No drought stress or nutrient stresses would occur, maximizing growth. This would be a challenge, as corn and other grasses typically exhibit calcium and micronutrient deficiencies when grown in commercial soil mixes (see Figure 1). Our secondary goal was for the system to be easily adopted. We looked for a root medium that did not need custom blending or augmentation with supplemental fertilizers, which might require special equipment and some amount of expertise.

After testing dozens of root media, we chose calcined clay granules for our system. Calcined clay, also known as porous ceramic, is nothing new; research reports date back over more than two decades. It is used for corn production by at least one large agriculture research firm and NASA. Being a clay product, it has a high cation exchange capacity (30 meq/ 100 g) and contains mineral nutrients including K, Ca, Mg, and Fe.

The system was first validated by the results of Experiment 1 (see Materials and Methodology) using a 15-5-15 fertilizer with Ca 5% and Mg 2%, applied at a strength of 200 ppm N. The fertilizer solution was used at each irrigation, seed to harvest. This formulation was used in a majority of the 24 studies reported here. Note that no supplemental fertilizers were required, either at planting or afterward.

We found no differences in plant growth according to fertilizer formulation. In Experiment 7, we compared an acidic 30-10-10 fertilizer with the 15-15-15, which is basic. Acidic fertilizers typically have more of the nitrogen in the ammoniacal form. Both were applied at a 200 ppm N strength. We saw no visual differences in vegetative growth. In Experiment 16, we again saw no differences in vegetative growth of plants fertilized with 15-3-16, 20-20-20 or 21-5-20, at 200 and 400 ppm N (see Figure 2 and Table 1). Note the shortcomings of these two studies: Neither were continued into the reproductive phase, and both were done in the low light season.

We know of two facilities that have reported improvements using 20-20-20 over other formulations (personal communication). In their excellent protocol, the Iowa State University Plant Transformation Facility reports using 15-5-15 for corn growing in a commercial soilless mix.

This document is based on materials originally posted to the Purdue University HLA Department Plant Growth Facility web site: http://www.hort.purdue.edu/hort/facilities/greenhouse/CornMethod.shtml

We did see differences in plant growth according to fertilizer strength. In Experiment 14, plants grown under 600 ppm N were significantly shorter than those grown under 200 ppm N (see Figure 3). We feel 600 ppm is too strong for corn in this growth system. In Experiment 15, we used 400 ppm N with good result. Seed yield for plants growing in Turface was 580 seeds/ear, compared to 500-530 seeds/ear of three previous studies with Turface. At termination of experiment, electrical conductivity of the media was normal at 2.2 mS/cm, indicating that the frequent fertilization did not result in accumulation of salts.

The quality of the domestic water supply should be considered before choosing any fertilizer formulation. Advice from Extension Specialists or from a fertilizer manufacturer's technical staff is recommended.

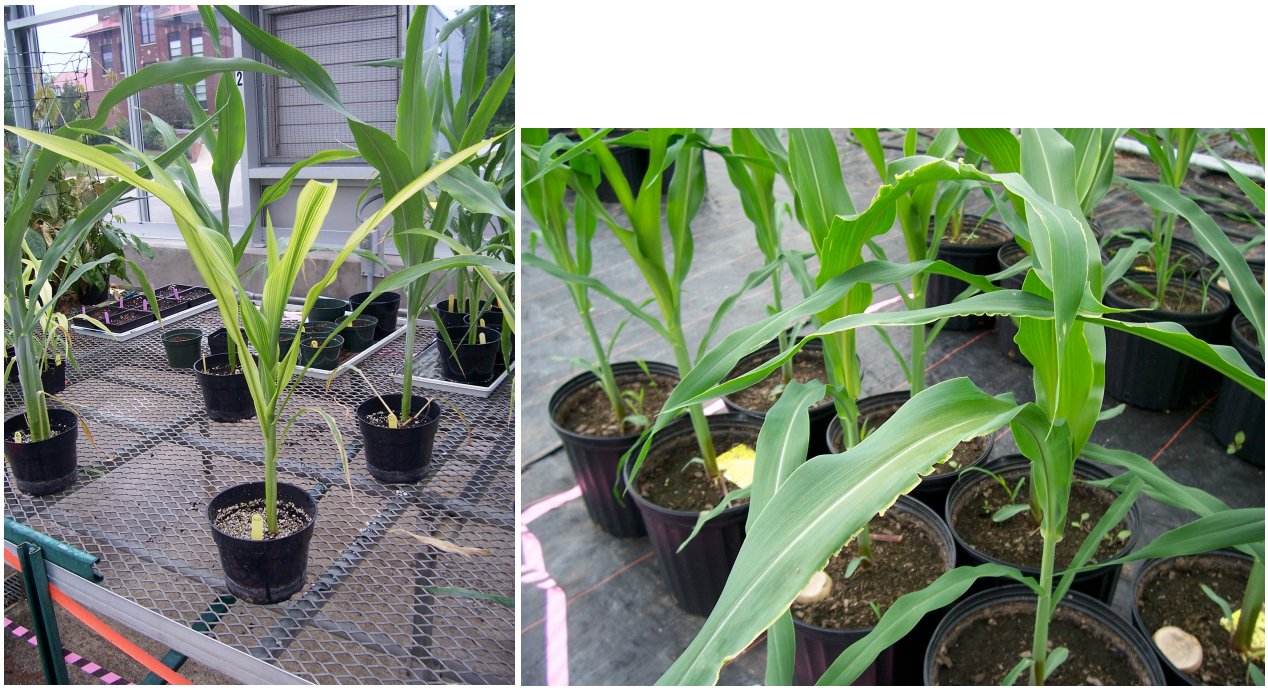

Figure 1. Typical iron chlorosis (left) and Ca deficiency in greenhouse corn.

Table 1. Height and leaf number of Experiment 16 corn plants grown under different fertilizer formulations and strengths, 50 days after sowing. No significant differences.

Treatment	Height (cm)	Leaves unfolded
15-3-16, 200 ppm N	124.8	5.8
15-3-16, 400 ppm N	122.0	5.3
20-20-20, 200 ppm N	123.0	5.8
20-20-20, 400 ppm N	123.0	5.7
21-5-20, 200 ppm N	125.8	5.4
21-5-20, 400 ppm N	127.0	5.6

Figure 2. Corn grown using three fertilizer formulations, each at two strengths. Left to right: 15-3-16 at 200 ppm N; 15-3-16 at 400 ppm N; 20-20-20 at 200 ppm N; 20-20-20 at 400 ppm N; 21-5-20 at 200 ppm N, and 21-5-20 at 400 ppm N. No visual differences were apparent.

Figure 3. Plants grown at 200 ppm N (left) and 600 ppm N in Experiment 14. Root medium is Turface calcined clay and fertilizer formulation is 21-5-20.

Figure 4. Some interveinal yellowing and calcium deficiency on plants grown under 200 ppm N in high light season. The plants recovered without corrective action. We increased to 400 ppm N for next study.